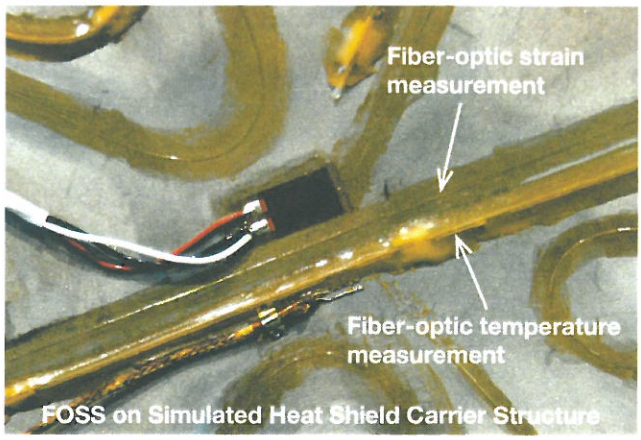
National Aeronautics and Space Administration

NASA's **Aeronautics Test Program**

Fiber Optic Sensing Systems Technology

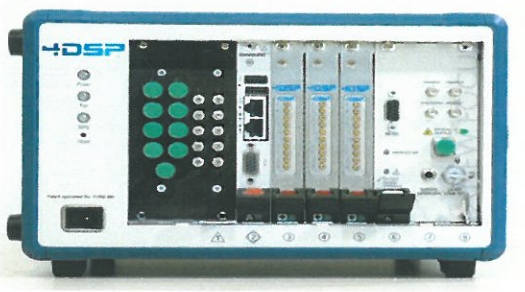
Revolutionary advances in Fiber Optic Sensing Systems (FOSS) technology, as applied to ground and flight strain measurement systems, have been achieved over the last decade and are expected to continue at a rapid pace for the foreseeable future. Significant maturation in both manufacturing optical fibers and miniaturizing system hardware has enabled the transition of this technology from controlled laboratory environments to realistic ground and aircraft applications. FOSS technology also enables the determination of other derived engineering parameters such as structural shape and applied loads: information that has not been available using conventional strain gage systems.

Over the past decade, researchers in the Flight Loads Laboratory, at NASA's Dryden Flight Research Center, have progressed FOSS technology from slow ground-based systems to systems suitable for health monitoring of ground and flight structures. Through advances in signal processing and advanced algorithms, FOSS technology is ready to meet the measurement requirements of today's most challenging ground- and flight-test applications.

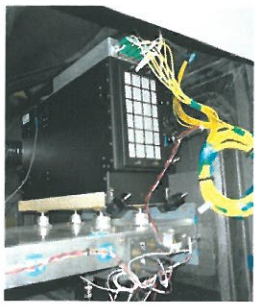


FOSS on Simulated Heat Shield Carrier Structure


FOSS on Composite Crew Module



Ground System



Flight System

FOSS Benefits

- Immune to electromagnetic / radio-frequency interference and radiation
- Lightweight fiber-optic sensors are amenable for embedment in composite structures
- Multiplex 1000s of sensors onto one optical fiber
- Uses a narrowband wavelength tunable laser source to interrogate sensors
- Typically easier to install than conventional strain sensors

FOSS Applications

- Conventional measurement parameters such as; strain, temperature, load, 3D shape, displacement, cryogenic liquid level
- Structural health monitoring
- Key projects supported: Ikhana (Predator B) Flight Test, Global Observer Flight Test / Wing Loads Test / Fuselage Test, Composite Crew Module, Composite Overwrapped Pressure Vessel Test, Gulfstream Quiet Spike Test

FOSS Ground System Characteristics

Available Systems	Six 8-fiber systems, one 16-fiber system (systems can be linked together for large tests)
System Attributes	
Sample Rate	Up to 60 sps for simultaneous sampling of 8 or 16 fibers
Recording	Real-time recording of engineering units
Interface	Ethernet for remote real-time monitoring
Size	7 in x 11 in x 12 in
Weight	18 lb
Temperature Range	40°F to 100°F
Fiber Attributes	
Fiber Length	40 ft
Sensors per Fiber	2048
Sensor Density	As small as 1/4 in spacing
Fiber Diameter	165 microns
Fiber Strength	20,000 microstrain
Fiber Coating	Polyimide
Temperature Range	-452°F to 550°F

FOSS Flight System Characteristics

System Attributes	
Sample Rate	Up to 60 sps for simultaneous sampling of 8 fibers
Recording	Real-time recording of engineering units
Interface	Ethernet for telemetry
Size	7.5 in x 13 in x 17 in
Weight	29 lb
Shock	8 g
Vibration	1.1 g-peak sinusoidal curve
Altitude	30,000 ft
Temperature Range	-69°F to 104°F

FOSS on Global Observer Wing Loads Test

Contact Information

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